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Original Research Article

"ELECTROLYTE IMBALANCE IN ACUTE GASTROENTERITIS IN CHILDREN OF BELOW 5 YEARS AGE GROUP"

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ABSTRACT:

Background: Acute gastroenteritis—diarrhoea or vomiting (or both) of more than seven days' duration—may be accompanied by fever, abdominal pain, and anorexia. Diarrhoea is the passage of excessively liquid or frequent stools with increased water content. Patterns of stooling vary widely in young children, and diarrhoea represents a change from the norm.

OBJECTIVES: To study the electrolyte imbalance in children suffering from acute gastroenteritis of children of under 5 age group.

MATERIAL & METHODS: Study Design: This is a prospective and observational study. Conducted at Tertiary Care Teaching Hospital over a period of 1 year. **Study population**: children suffering from acute gastroenteritis dehydration admitted to the Pediatrics Department**. Sample size:** study consisted a total of 80 study subjects. **Sampling method:** Simple random sampling method. **Study tools and Data collection procedure:** These patients were clinically evaluated to assess the severity of dehydration according to WHO criteria[6]. The nutritional status was determined at the time of admission by the weight for age criteria as recommended by the Indian academy of Paediatrics[7]. In all these patients, serum sodium, potassium was estimated before starting the treatment. The same were estimated in 10 apparently healthy children who served as control. Three milliliter of venous blood was collected under strict aseptic measures which were kept in centrifuge tubes for serum electrolyte, estimation.

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Results: In Grade-I malnutrition, the mean sodium levels were 131.4, 129.6 and 125 in mild, moderate and severe degree of dehydration respectively. The mean levels in mild, moderate and severe dehydration of Grade-II were 129.5, 128,125.3 mEq/lt respectively. In Grade-III malnutrition it was 125.75 in moderate and 120.6 mEq/lt in severe dehydration.

CONCLUSION: From our study, it can be concluded that, Hypokalemia was the commonest electrolyte imbalance amongst the malnourished cases while isonatremic dehydration was commoner among normal nourished children. The severity of hyponatremia was more or less proportionate to the degree of dehydration and the grade of malnutrition. Hypokalemia was also more marked among severely dehydrated cases.

Keywords: Acute gastroenteritis, Hypernatremic dehydration, Hypokalemia

INTRODUCTION:

Acute gastroenteritis—diarrhoea or vomiting (or both) of more than seven days' duration—may be accompanied by fever, abdominal pain, and anorexia. Diarrhoea is the passage of excessively liquid or frequent stools with increased water content. Patterns of stooling vary widely in young children, and diarrhoea represents a change from the norm.[1] Worldwide, 3-5 billion cases of acute gastroenteritis and nearly 2 million deaths occur each year in children under 5 years.[2]

Dehydration and electrolyte imbalance are the main factors of death in diarrheal diseases. These losses can occur quickly in infants and children. The loss of fluid and electrolytes may be proportionate or disproportionate to each other resulting in states of isotonic, hypotonic and hypertonic dehydration differs. Isotonic solutions which are commonly used in dehydration states may not be suitable at all in hypernatremic conditions and likewise fluids containing low amounts of salts would not suffice in hyponatremic states. It is not always possible to determine the amount of fluid and the type of salt loss for replacement therapy in these emergency situations.

Hypernatremic dehydration is common in developed countries where children are fed with solute rich feeding formula[3]. In the developing countries hyponatremic dehydration is very common[4]. Thus the type of dehydration varies with place and situations. Although WHO has recommended to start isonatremic solution in developing countries where hyponatremic dehydration is very common, yet in particular place and particular situations there may be deviations. Thus it is necessary to have a basic parameter of the dehydration states in each area.

It is important to assess hydration in gastroenteritis as hydration status determines the immediate management of this condition. The infant or child with profuse watery diarrhoea and frequent vomiting is most at risk. Clinicians often overestimate the extent of dehydration. Clinical signs are usually not present until a child has lost at least 5% of his or her body weight. Documented recent weight lost is a good indicator of the degree of dehydration, but this information is rarely available. The best clinical indicators of more than 5% dehydration are prolonged capillary refill, abnormal skin turgor, and absent tears.[5]

The loss of fluid and electrolytes may be proportionate or disproportionate to each other resulting in states of isotonic, hypotonic and hypertonic dehydration differs. Isotonic solutions which are commonly used in dehydration states may not be suitable at all in

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hypernatremic conditions and likewise fluids containing low amounts of salts would not suffice in hyponatremic states.

Hence the present study was undertaken to study the electrolyte imbalance and to determine the amount of fluid and the type of salt loss for replacement therapy in these emergency situations.

OBJECTIVES: To study the electrolyte imbalance in children suffering from acute gastroenteritis of children of under 5 age group.

MATERIAL & METHODS:

This is a prospective and observational study. Conducted at Tertiary Care Teaching Hospital over a period of 1 year.

Study population: children suffering from acute gastroenteritis dehydration admitted to the Pediatrics Department

Sample size: study consisted a total of 80 study subjects.

Sampling method: Simple random sampling method.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and Data collection procedure:

These patients were clinically evaluated to assess the severity of dehydration according to WHO criteria[6]. The nutritional status was determined at the time of admission by the weight for age criteria as recommended by the Indian academy of Paediatrics[7].

Grade 1: 80-70% of expected weight

Grade 2: 70-60% of expected weight

Grade 3: 60-50% of expected weight

Grade 4: Less than 50% of expected weight

In all these patients, serum sodium, potassium was estimated before starting the treatment. The same were estimated in 10 apparently healthy children who served as control. Three milliliter of venous blood was collected under strict aseptic measures which were kept in centrifuge tubes for serum electrolyte, estimation.

0.2ml of Serum was diluted with 19.8 ml at glass distilled water, calibrationwas done using high and low sodium and potassium working standards (170 mEq/lit and 120 mEq/lit. of Na^+, 8 mEq/lit & 3mEq/lit of K^+ respectively.

Test readings were calculated using the formula:

$$\frac{\text{Analog Reading of Test}}{\text{Analog reading of standard}} \times \text{Concentration of standard in mEq/l.}$$

Statistical analysis: The data was entered in the Microsoft excel sheet and double checked for errors. Analyses were done using Epi info 3.5.2 and SPSS Software trial version-21 and MS Excel 2013. Results are presented as percentages, mean and Standard Deviation. A p value of <0.05 is considered statistically significant and <0.01 or 0.000 as highly statistically significant.

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OBSERVATIONS & RESULTS:

Table 1: Age & sex distribution and nutritional status of cases admitted with Post Diarrheal Dehydration

Age group	Total no.of cases =80	Male = 52		Female = 28	
		No	%	No	%
1-12 months	42	34	42.14	21	17.35
13- 36 months	24	12	18.18	12	9.91
3-5 years	14	5	6.61	7	5.78

Table 2: Age distribution and nutritional status of cases admitted with Post Diarrheal Dehydration

Age group	Total number of cases =80	Normal nourished	Grade 1 malN	Grade 11 malN	Grade 111 malN	Grade 1V malN	Total
1-12 months	42	22	9	13	11	17	50 (41.32%)
13-36 months	24	7	6	8	5	8	27 (22.31%)
3-5 years	14	8	1	1	2	3	3 (5.7%)

The nutritional status of 23 cases (28.75%) was normal as per Harvard standard. Among the malnourished, 12 cases (15%) belonged to Grade I, 18 (22.5%) to Grade II, 11 (13.75%) cases to Grade III and 16.9(20%) to Grade IV groups. The clinical degree of dehydration was mild in 10 (12.5%) cases, moderate in 45(56.255), and severe in 25(31.25%) cases.

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Table 3: Degree of dehydration of patients in relation to Nutritional Status

Nutritional status	Total cases = 80	Mild dehydration	Moderate dehydration	Severe dehydration
Normal	36 (30.5%)	4	26(21.48%)	7(5.7 %)
I	16 (19.04%)	5	7	4
II	12(26.19%)	3	15	4
III	18(21.4%)	--	12	6 (29.75%)
IV	8(33.3%)	1	5	22

Among the malnourished cases, 8 (14%) suffered from mild degree of dehydration and 29 cases (50.85) from moderate and 21 cases (36.8%) had severe degree of dehydration were more common among malnourished children.

Table 4: Serum sodium (mEq/lt) in relation to Nutritional and Dehydration status

Nutritional status	Mild dehydration Mean $^{+}_{-}$ S.D (Range)	Moderate dehydration Mean $^{+}_{-}$ S.D (Range)	Severe dehydration Mean $^{+}_{-}$ S.D (Range)
Normal	**138.92 $^{+}_{-}$ 2.27 (136-142)**	**133.52 $^{+}_{-}$ 4.6 (128.5- 141.5)**	**132.64 $^{+}_{-}$ 2.4 (129-136)**
I	**131.8 $^{+}_{-}$ 1.93**	**131.2 $^{+}_{-}$ 2.5**	**125.8 $^{+}_{-}$ 3.3**

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II	**130.33 +–1.24**	**127.5+– 2.54**	**124.6 +– 3.3**
III	**----**	**126.6 +– 2.6**	**121.2 +– 1.5**
IV	**124**	**122.6 +– 1.4**	**120.9 +– 1.91**

Table 5: Serum Potassium (mEq/lt) in relation to Nutritional and Dehydration status

Nutritional status	**Mild dehydration Mean +– S.D (Range)**	**Moderate dehydrationMean +– S.D (Range)**	**Severe dehydration Mean +– S.D (Range)**
Normal	4.01 +– 0.42 (3.4 – 4.5)	3.79 +– 0.45 (2.85 – 5)	3.65 +– 0.52 (3.0 – 4.65)
I	3.42 +– 0.47 (2.5-3.7)	3. 92 +– 0.30 (3.4-4.3)	3.06 +– 0.28 (2.7-3.45)
II	3.53+– 0.47 (3.5-3.6)	3.38 +– 0.39 (2.25-3.7)	3.4+– 0.37 (2.8-3.8)
III	---	3.47+– 0.21 (2.8-3.7)	3.2+– 0.37 (2.6-3.6)
IV	3.3	3.1 +– 0.30 (2.7-3.5)	2.98+– 0.64 (2.00-3.55)

There are 10 control cases who were normally nourished and without any evidence of dehydration. The serum sodium levels of these children ranged from 136-145 mEq/lt with a mean of 141.2 mEq/lt. serum potassium ranged from 3.5-4.7 mEq/lt with a mean of 4.26 mEq/lt.

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Children suffering from acute gastroenteritis with dehydration had mean sodium of 127.6 with range 118-141.5 mEq/lt. serum potassium ranged from 2-3.7 mEq/lt with mean 3.45 mEq/lt .

The mean levels of sodium in children with dehydration and with normal nutrition were 204.5, 142.14 and 132.9 in mild, moderate and severe degree of dehydration respectively.

In Grade-I malnutrition, the mean sodium levels were 131.4, 129.6 and 125 in mild, moderate and severe degree of dehydration respectively. The mean levels in mild, moderate and severe dehydration of Grade-II were 129.5, 128,125.3 mEq/lt respectively. In Grade-III malnutrition it was 125.75 in moderate and 120.6 mEq/lt in severe dehydration. The mean levels of Grade-IV malnourishment with mild, moderate and severe dehydration were 124,122.5 and 123.45 mEq/lt. It was observed that serum sodium level decreased to a greater extent with degree of dehydration ($P < 0.001$) and degree of malnutrition ($P < 0.001$).

DISCUSSION:

The loss of fluid in diarrheal disorders is also associated with loss of many electrolytes. The later mainly includes sodium, potassium and bicarbonate. The amount of loss of these electrolytes is influenced by the amount and type of fluid lost from the body by the kidneys. In addition to this the overwhelming infection associated with diarrhea might affect other organ systems.

Newborns and infants because of their immature immunological response are particularly susceptible to infection especially if they are not breast fed. Moreover, they are easily prone to dehydration and electrolyte imbalance because of greater water content, large turnover and increased insensible water loss from their body[8].

The incidence is found to be more common amongst malnourished children (69.42%). When compared to normal nourished children (30.57%). The finding correlates with the work of various workers[9,10]. Conditions of food inadequacy are responsible for altered immunity which in turn increases the susceptibility to infections, while such episodes of infection can precipitate nutritional deficiencies. These mutual infections between malnutrition and infection constitute a vicious cycle[11].

The levels of electrolytes are low in malnourished children[12] and the condition is aggravated when diarrhea and vomiting ensures. In the present series 69.42 cases were under nourished. In the normal nourished patients, the incidence of isonatremic dehydration was 72.9% of the severity of dehydration. But hyponatremia was 72.9% of the severity of dehydration. But hyponatremia was more common among malnourished children with an incidence of 73.8%. Further it was seen that hyponatremia was more severe in grade IV malnourishment. The severity of the degree of hyponatremia was more or less proportionate with the severity of malnutrition. There was not a single case of hypernatremia. Similar findings were also found in earlier Indian studies. Sharma et al[13] found hyponatremia in 52.3% of children with diarrhea and dehydration, where asisonatremic dehydration was seen in 47.75 cases, Mittal et al[14] showed that in 2/3rd of malnourished children hyponatremia was the commonest abnormality. However, in normal nourished children isonatremic dehydration was commonest (66.4%). In developed countries hypernatremia is commonest electrolyte imbalance in children suffering from diarrhea with dehydration. Ironsideet al[1] found hypernatremia in 63% children and hyponatremia in 55%. This is probably because of

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concentrated feeding formula being given to them. In developing countries, since hyponatremia is a common accompaniment in diarrhea with dehydration, one could infuse isotonic saline in such patients without waiting for reports of serum sodium levels.

Hypokalemia was seen in 31.4% cases. Out of them 18.9% were normal nourishes children and 36.9% were malnourished. The levels of potassium were lower in malnourished children. The severity of hypokalemia was also proportional to degree of dehydration. Not a single case had hyperkalemia. These findings correlated with the study of other workers. In a study conducted by Sharma et al[13], they found normokalemia in 95% cases, 3% had hyperkalemia and only 2% had hypokalemia. Thus potassium infusion can be given as a routine in cases with malnutrition and severe dehydration due to gastroenteritis.

Thus in children suffering from diarrhea and dehydration in developing countries a fluid which contains normal saline, potassium, sodium bicarbonate could be infused without waiting for the investigating reports. Out of six cases that expired, one case died probably because of associated encephalitis. Two cases had features evident of acute renal failure. Septicemia and peripheral circulatory failure was probably responsible for the death of other cases. Therefore, if septicemia is associated, proper antibiotics should be started simultaneously in combination with dehydration therapy.

Many types of solutions are administered intravenously to provide nutrition to people who cannot otherwise take adequate amounts of nutrition. Glucose solutions are widely used, and amino acid and homogenized fat solutions are used to a lesser extent. When these solutions are administered, their concentrations of osmotically active substances are usually adjusted nearly to isotonicity, or they are given slowly enough that they do not upset the osmotic equilibrium of the body fluids. After the glucose or other nutrients are metabolized, an excess of water often remains, especially if additional fluid is ingested. Ordinarily, the kidneys excrete this in the form of very dilute urine. The net result, therefore, is the addition of only nutrients to the body.

The primary measurement that is readily available to the clinician for evaluating a patient's fluid status is the plasma sodium concentration. Plasma osmolarity is not routinely measured, but because sodium and its associated anions (mainly chloride) account for more than 90 per cent of the solute in the extracellular fluid, plasma sodium concentration is a reasonable indicator of plasma osmolarity under many conditions. When plasma sodium concentration is reduced more than a few mill equivalents below normal (about 142 mEq/L), a person is said to have hyponatremia. When plasma sodium concentration is elevated above normal, a person is said to have hypernatremia.

Thus isotonic saline could be started in all cases of diarrhea with dehydration without waiting for serum sodium repots. Since there is loss of potassium and acidosis, Ringer's lactate solution should be considered as preferred solution for initial therapy in all cases of diarrhea with dehydration, especially in developing countries where hyponatremic dehydration is more prevalent and determination of serum electrolytes prior to therapy is not feasible.

CONCLUSION:

From our study, it can be concluded that, Hypokalemia was the commonest electrolyte imbalance amongst the malnourished cases while isonatremic dehydration was commoner among normal nourished children. The severity of hyponatremia was more or less

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proportionate to the degree of dehydration and the grade of malnutrition. Hypokalemia was also more marked among severely dehydrated cases.

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